OECD/IEA

COMMITTEE ON ENERGY RESEARCH AND TECHNOLOGY
END-USE WORKING PARTY

Implementing Agreement on Energy Conservation through Energy Storage

Annual Report 1998

June 1999

EXECUTIVE SUMMARY

The year 1998 has been a year in between - starting of new annexes, welcoming new countries and participating in STOCK-Conferences - although full of activities. The Implementing Agreement celebrated in a dignified way its 20th Anniversary at the ”roof of New Mexico”, USA, during the autumn meeting in December 1998.

The Executive Committee has taken special concern of the Conferences EESAT ‘98 and 2nd Stockton International Conference. A great administrative effort was spent on the 1998 CERT Review of the Implementing Agreement for the period 1995- 1997 and the preparatory work for the new Strategic Plan for 1999-2003.

The EESAT ‘98 was an important milestone and a position-maker for the Technology advance on the topic on Electrical Energy Storage. The Conference attracted some 140 delegates from 15 countries, was a major dissemination event for the Annex 9, and also honoured by the Director of the IEA, Hans Jörgen Koch, who spoke in the opening session.

The 2nd Stockton International Conference (some 150 delegates) had a broad contribution of presentations both from annex 8 experts and outside annex 8. Workshops on computer modelling were also arranged back to back to the Conference. Another important result from this Conference was the Electronic Journal of Underground Thermal Storage and Utilization - with and without heat pumps. An International Peer Reviewed Journal on Energy Conservation
(http://www.geo-journal.stockton.edu/)

The CERT review is undertaken every four years and forms an integral part of the ongoing overview of the IEA Energy Technology Collaboration activities by the CERT.

The Implementing Agreement’s report to the CERT was discussed and reviewed by the EUWP. The Discussant’s report complimented the Agreement for its objectives, activities and operations. The objectives and goals are general and broad and reflect the nature of the area. Although, the report encouraged further broadening of the scope of the Agreement’s activities and suggested that alternate Executive Committee members could be appointed with complementary experience.

The Strategic Plan for the Implementing Agreement outlines the scope and the goals of the Storage Programme for the five-year period 1999-2003. It will serve as the basic working document to guide the future work. The Mission of the Programme is *”to research, develop, implement and integrate energy storage technologies to optimise energy utilisation by improving overall energy efficiency and economic growth while benefiting the local and global environment.”*

The Implementing Agreement has also been involved in other collaborative activities also with other Implementing Agreements:

- The Future Building Forum arranged a workshop in Stockholm, June 1998 on the subject of Low Temperature Heating Systems and High Temperature Cooling Systems where the UTES activities and prospects were presented.
- The preparation works for the EUWP Seminar in Stockholm, April 1999, where the Strategy Plan for the Implementing Agreements in the Building Sector will be presented and discussed,
- The preparation work for the TERRASTOCK 2000 Conference, Stuttgart, Germany, September 2000,
- The Energy Storage Conference in Indore, India, February 1999, in which India expressed interest to participate in the IEA Storage activities.

Three annexes (10, 12 and 13) started the activities during the year (formal decision on start - December 1997) and have been worked out very well. The state-of-art and detailed workplan and specifications have been discussed and documented in workshops and expert meetings for each annex. Through the ongoing annexes (8-13) the collaboration with other implementing agreements will continue in the way that have been outlined in the Annual reports 1996 and 1997.
The activities in the annexes are the cornerstones of the Implementing Agreement and hence, of greatest importance for the IA's business.

IEA ECES IA - Executive Committee

Introduction
The Implementing Agreement (IA) started in 1978 and was recently extended to the year 2000. It has now (1998) 14 members: Belgium, Bulgaria, Canada, CEC, Finland, Germany, Italy, Japan, the Netherlands, Poland, Sweden, Turkey, United Kingdom, and USA. During the past year the Executive Committee has worked intensively to attract more countries to join the activities and to sign the Implementing Agreement. As a consequence Japan, Poland and Bulgaria are new members of the year and Australia, China, India, South Africa, Spain and Switzerland have expressed interest to participate in the activities of the Implementing Agreement.

The Executive Committee is working on the Strategy Plan for the period 1998 - 2000, which mainly will be an update of the present Strategy Plan (1994-1997).

According to the present Strategy Plan the objectives for the IA are:

"The overall objective of the IA on ECES is to develop and demonstrate various energy storage technologies for applications within a variety of energy systems and to encourage their use as a standard design option. Energy storage technologies can improve the utilisation of renewable energies, in particular solar and wind and the greater utilisation of waste heat energy storage technologies should be implemented in all countries with significant energy storage market potential."

The Executive Committee co-ordinates and leads the collaborative work in the annexes and the Committee also takes an active part in various information activities such as workshops, seminars and conferences. Recently, the following major conferences are worth mentioning.

- EESAT'98 in Chester, UK (June 1998) on Electrical Storage
- 2nd International Stockton Geothermal Conference, March 1998
- Energy Storage for Meeting Power Crisis: A Futuristic Option, February 1999, Indore, India
- TERRASTOCK '2000 September 2000 in Stuttgart, Germany

During the year the Executive Committee was engaged in the planning, and performing of these conferences.

The Executive Committee had two meetings during the year. The first meeting was held in Chester, UK in June and in Albuquerque, USA, in December.

<u>The Chester Meeting, June 1998</u>
The most important items and decisions of the Chester meeting are outlined below.

- The Implementing Agreement was reviewed by the CERT during spring and the results were that the IA has a good development with a broader scope of work, which had

contributed to the attraction of new countries. The challenges were to have a common fund for the secretariat's expenses and to introduce a new Strategy Plan.
- The work in the annexes proceed very well which are the basis for success and attraction to the IA.
- The collaboration with other IAs is important and emphasised. It will be organised through the work in the annexes and by the secretariat. Assistance from the IEA office is necessary.

The Albuquerque Meeting, December 1998

The most important discussions and decisions are outlined below.
- New countries of interest, South Korea (observer at the meeting), India, China, Spain (member February 1999), Switzerland, Poland, Bulgaria.
- The IA 20 year anniversary
- 1st draft new Strategy Plan
- Decision on Common fund for the Secreatriat's extra costs.
- Decision on task definition phase for a new annex: Cooling in All Climates with Thermal Energy Storage (TES)
- Approval of all annex reports and the extension of Annex 12, phase 1.

IEA GENERAL INFORMATION

Framework of the International Energy Agency (IEA)

Established in 1974 with headquarters in Paris, the IEA is the energy forum for 24 industrial countries - Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Union also participates in the work.

The IEA, based in Paris, is an autonomous agency linked with the Organisation for Economic Co-operation and Development (OECD). The IEA's main decision-making body is the Governing Board, composed of senior energy officials from each Member country. Under normal circumstances, the Governing Board holds regular meetings several times a year. Meetings at Ministerial level are held every two years.

The Governing Board directs the activities and makes the major policy decisions of the IEA. It regularly reviews the world energy situation as well as domestic energy policies to assess future energy supply and demand patterns and to determine policies to meet changing energy and economic conditions.

A Secretariat, with a staff of energy experts drawn from Member Countries, supports the work of the Governing Board, the Standing Groups and Committees. The IEA Secretariat collects and analyses energy data, assesses Member countries' domestic energy policies and programmes, makes projections based on differing scenarios and prepares studies and recommendations on specialised energy topics. An Executive Director appointed by the Governing Board heads the IEA Secretariat.

The countries participate in the IEA to safeguard the members' collective energy security, and thereby reduce the economic risks, associated with energy shortages. Steps to safeguarding from economic risks has included reducing dependency on oil imports, the sharing of oil supplies in emergencies, the promotion of more stable world oil markets and the initiation of collaborative research on new and efficient energy technologies.

The future promises fundamental changes in the global energy balance. Higher economic growth rates will result in non-industrialised nations accounting for more than 60% of the world energy demand by the end of the century. The growing concern for environmental issues also having a strong influence on the nature of national and global energy priorities. IT appears that the need for international collaboration in energy strategy continuing to increase in importance.

Objectives

- To maintain and improve systems for coping with oil supply disruptions;
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations;
- To operate a permanent information system on the international oil market;
- To improve the world's energy supply and demand structure by developing

alternative energy sources and increasing the efficiency of energy use;
- To assist in the integration of environmental and energy policies.

Shared Goals

The 24 Member countries of the International Energy Agency (IEA) seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments.

IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

- Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydropower, make a substantial contribution to the energy supply diversity of IEA countries as a group.
- Energy systems should have the ability to respond promptly and flexibly to energy emergencies. In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.
- The environmentally sustainable provision and use of energy is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.
- More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA members wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.
- Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by Governments and all energy users are needed to realise these opportunities.
- Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.
- Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the

extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.
- Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.
- Co-operation among all energy market participants helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

The IEA Ministers adopted the "Shared Goals" at their 4 June 1993 meeting in Paris.

Committee on Energy Research and Technology (CERT)

Fostering energy technology innovation is a central aspect of the IEA's work. Development of safer, more efficient technologies is imperative for energy security, environmental protection and economic growth. Equally essential is the widespread deployment of these more economical, environmentally benign technologies. But progress in energy technology research, development, demonstration and deployment implies investment. Two decades of IEA experience have shown that international collaboration on these activities avoids duplication of effort, cuts costs and speeds progress.

The IEA's Energy Technology Collaboration Programme operates under the guidance of the Agency's Committee on Energy Research and Technology (CERT) and its subsidiary bodies dealing with technologies for fossil fuels, renewable energy, efficient energy end-use and fusion power, as well as its expert groups on electric power technologies and technology assessment methodologies. The Programme enables experts from different countries to work collectively and share results, which are usually published. The Programme's objectives are
- improved energy efficiency and technology reliability;
- enhanced access to up-to-date assessments of energy technology performance;
- reduced environmental impact of energy-sector activities;
- Co-operation with non-member countries.

Practical elements of the Programme include:
- policy analysis through reviews of energy technology and R&D programmes in Member and selected non-member countries, thereby encouraging common approaches;
- sharing of practical experience and exchange of information through joint studies, conferences and workshops that monitor technological advances in key areas and enhance visibility for leading-edge techniques; and
- collaborative research projects. IEA Implementing Agreements offer the framework for these collaborative research projects.

The projects aim to:
- expand basic understanding of existing technical processes and reduce their costs;
- remove barriers to market deployment;

- foster sharing of operating experience and expand general awareness of technological capabilities.

The Implementing Agreements provide the legal mechanism for establishing participants' commitments and the project's management structure, and for ensuring distribution of benefits from the co-operative work while protecting participants' intellectual property. Activities are managed jointly by experts from IEA Member and non-member countries (representing government bodies, industry, academia and other international organisations). Resources come from participants. Benefits include not only pooled resources and shared costs, but also harmonisation of standards and hedging of technical risks. The IEA programme places emphasis on expanding co-operation with industry.

More than 30 countries are involved in Europe, America, Asia, Australia and Africa. Flexible and dynamic, the programme is expanding steadily as the advantages of international collaboration secure wider recognition. Some forty Agreements operate currently, involving a total of some US$100 million. They cover the full range of technologies used in the production, transformation, distribution and end-use of energy. Among the many areas covered by Agreements are bio-energy, solar heating and cooling, wind turbine systems, advanced fuel cells and electric vehicles. Energy technology information centres have also been set up under the programme. Concern for the protection of the environment is reflected strongly in the mandates of both long-standing and more recent Implementing Agreements.

Working Parties

The four Working Parties are the Working Party on **Energy end-Use Technologies**, the Working Party on **Fossil Fuels**, the Working Party on **Renewable Energy Technologies** and the **Fusion Power Co-ordinating Committee**. Working parties are composed of government officials from member countries who have a broad knowledge of their countries' activities in those particular areas. They help focus research and development initiatives and review the status of technology development and deployment. Working Parties identify areas of mutual interest among countries and, if warranted, initiate Implementing Agreements, which they then review and guide on a regular basis. Working Parties also exchange information on the status of national programs and on the development of technologies.

Working Party on Energy End Use Technologies

Infrastructure energy systems, buildings, industry, agriculture and food, electricity end-uses and crosscutting technologies are the current thrust areas of this Working Party. The following lists the active Implementing Agreements of the IEA which are guided by the Working Party on Energy End-Use Technologies.

Implementing Agreements

- Advanced Fuel Cells
- Alternative Motor Fuels
- Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET)
- District Heating and Cooling
- Electric Vehicle Technologies and Programs
- Energy Conservation and Emissions Reduction in Combustion
- Energy Conservation in Buildings and Community Systems
- Energy Conservation through Energy Storage

- Energy Technology Data Exchange (EITDE)
- Impacts of High-Temperature Superconductivity in the Electric Power
- Program of Energy Technology Systems Analysis (ETSAP)
- Pulp and Paper

An **Implementing Agreement**: is a framework, which facilitates the initiation, implementation monitoring and review of international collaborative efforts. Implementing Agreements can encompass any phase of the technology cycle research and development demonstration, validation of technical environmental and economic performance: market deployment or information: exchange: Member countries choose to participate in those-Implementing Agreements which best meet their needs.

Implementing Agreements are flexible and are set up to meet the requirements of those countries that wish to take part. Participants can be member country government organisations, semi-private entities (including universities) and private organisations when formally designated by the national government. Non-member countries may also join a given Implementing Agreement under a mechanism termed **Associate Participation**, provided **they obtain prior consent** from the IEA Governing Board. Private organisations not formally designated by their government, and non-intergovernmental international entities may also join the Implementing Agreement under a special designation termed **Sponsor Participation** provided they obtain prior approval from the Committee on Energy Research and Technology.

The initiative for an Implementing Agreement is usually taken by interested countries, which work with the IEA Secretariat and the Working Parties to draft a program of work. The proposed Implementing Agreement is first considered by CERT and then by the IEA Governing Board. Once approved, an **Executive Committee**, made up of one representative from each country, which joins the Agreement, develops a strategy for carrying out the research and development. If an implementing Agreement involves sizeable or varied work, it may be broken down into Annexes. Interested countries may choose to join all the Annexes, or only those which fulfil their requirements. An **Operating Agent** is elected for each Annex to act as project manager;

The IEA has no central funds to finance the Implementing Agreements, thus all resources are supplied by the participating countries. Two methods exist for financing an Implementing Agreement:

1. Cost-sharing: the participating countries contributing monetary resources to a common fund for equipment purchase or the operation of test facilities or information processing centres, and

2. Task-sharing: each participating country undertakes to devote specific resources and personnel to carry out part of a common work program.

Implementing Agreements are legal documents signed at a senior level such as the

ambassador to the OECD.

IEA IA Energy Conservation through Energy Storage Activities

Workshops and Conferences

Workshops 1998

Annex 9: Electrical Energy Storage for Utility Network Optimisation
Annex 10: PCM and Chemical Reactions for Thermal Energy Storage
Annex 12: High Temperature Energy Storage
Annex 13: Design, Construction and Maintenance of UTES Wells and Boreholes

Conferences 1998

EESAT '98. The first international conference on Electrical Energy Storage Systems Applications & Technologies, held in Chester in June 1998.

The Richard Stockton College Geothermal Heat Pump Conference,16.-17.3.1998, Pomona, N.J., USA.

Ongoing Annexes

Annex 8. Implementing Underground Thermal Energy Storage

Operating Agent: B. Nordell, Luleå University of Technology, Sweden.

1. Introduction

The general objective of Annex 8 is to conserve energy and improve the environment by speeding the introduction of Underground Thermal Energy Storage Systems (UTESS) into the building, industrial, agricultural and aqua-culture sectors. Originally Annex 8 was planned for five years (from May 1994). Later we had to change the time plan to follow the time plan of ECES IA. When the IA was extended also Annex 8 goes back to its original time schedule. At the start the annex had four participants Canada, Germany, Netherlands and Sweden. Later on Belgium, Turkey, USA and Japan joined the collaboration. Several more countries have shown their interest (Australia, Poland, and Finland) by attending the experts meetings as observers.

There have been nine Expert's Meetings over the years and the 10th and final meeting will be held in Sweden, June 1999. At this occasion the Annex 8 will be terminated but there will also be a Workshop to discuss a new annex. The aim of this workshop is to define the best way to continue part of the Annex 8 work.

Annex 8 Expert's Meetings

	Location	Date	No. Experts	No. Countries	Participants	Observers
1.	Uppsala Sweden	4-6 May 1994	13	6	Swe Ger Can NL	Fin Bel
2.	Arnhem Netherlands	7-9 Nov 1994	11	6	Swe Ger Can NL	UK, Bel
3.	Freising Germany	25-27 Apr 1995	10	6	Swe Ger Can NL	Bel Tur
4.	Adana Turkey	13-15 Nov 1995	10	7	Swe Ger Can NL Bel Tur	USA
5.	Halifax Canada	10-11 Jun 1996	12	8	Swe Ger Can NL Bel Tur USA	Jap
6.	Leuven Belgium	27-29 Nov 1996	15	9	Swe Ger Can NL Bel Tur USA	Jap Fin
7.	Sapporo Japan	13-14 Jun 1997	18	10	Swe Ger Can NL Bel Tur USA Jap	A Pol
8.	Pomona, NJ USA	23-24 Mar 1998	13	9	Swe Ger Can NL Bel Tur USA Jap	Pol
9.	Warsaw Poland	17-19 Nov 1998	14	10	Swe Ger Can NL Bel Tur USA Jap	Pol Den
10.	Luleå Sweden	10-12 Jun 1999				

During the year two new annexes were started as a result of Annex 8 discussions on necessary UTES R&D.

- Annex 12, High Temperature UTES (HT UTES)
- Annex 13, Design, Construction and Maintenance of UTES Wells and Boreholes

The Annex 8 experts have also suggested another annex;

- Annex 14, Cooling in All Climates With TES. In the preparation work this annex has changed name from Low Temperature UTES. In June 1999 a workshop will finally define the scope of work for this annex.

2. Present UTES situation in participating countries.

Belgium: Rapid development of ATES systems. Continues with the Potential Study to include DTES also. Canada: Slow UTES development. Germany: Many UTES projects planned, both ATES and DTES. Work plan: The IEA Demo UTES Projects will be completed. Japan: Interesting development. The Heat Pump and Thermal Storage Centre of Japan (HPTSCJ) sent a survey delegation of 10 persons to Europe at the end of October. Some of facilities they visited were related to UTES. Most UTES interest in snow melting applications. Netherlands: Growing market for cold storage. About 40 ATES plants today and 500 ATES plants estimated by 2020. Average capacity 800 kW cooling. For smaller systems - DTES. Has distributed the final report (Phase II) "Applications and cost-effectiveness of energy storage in the Netherlands". Poland: Experience of deep geothermal energy Some UTES experience. Sweden: Increasing interest in UTES cooling applications in connection with District Cooling. Large number of BTES for direct cooling of telephone switching stations. Study on a solar heated high temperature DTES in Rock for LT Heating of 100 Single-family Houses (Pre-Study). New DTES drilling equipment developed - enables much deeper DTES. Turkey: Increasing UTES interest as a result of seminars, radio and TV programs, papers etc. General awareness of UTES is low but green-house producers and architects have expressed interest. The Turkish Potential study is now in a draft version for review by the experts. Work plan till the end of 1999. USA: GHPC implementation. Training centres for engineers and architects. Mobile training equipment. Totally installed 1.6 GW geothermal cooling power > 1000 commercial projects. Plans to start up a project on Technology Transfer to Developing Countries. Introduction of electronic journal. Continues on implementation of non-HP cold storage project in US.

3 Recent Developments

- Good UTES development was reported from most of the participating countries
- One observer represented Denmark for the first time at XM8
- Seasonal Thermal Energy Storage Newsletter, STES, October 1978 - February 1993 is now available on ECES IA homepage (Annex 8)
- Underground Thermal Storage and Utilization (UTSU) - A Peer Review International Journal on Energy Conservation, is now available on Internet (link from our homepage). Newsletter – linked to UTSU?

- Annex 8 experts are available as reviewers for the UTSU Journal. For this purpose we need instructions or a checklist for the review. We are all requested to submit articles to UTSU
- Road Cooling - new application tested by the Dutch Organisation for Roads and Water Ways. It seems to work well and have prevented both icing and reduced maintenance. The road surface is supposed to last 30-40 years with embedded pipes compared to 20 years normally.

As a result of Annex 8 discussions on necessary UTES R&D new Annexes have been suggested. Two new annexes have been started:

- Annex 12, High Temperature UTES (HT UTES)
- Annex 13, Design, Construction and Maintenance of UTES Wells and Boreholes

One more annex is being prepared:

- Annex 14, Low Temperature UTES (LT UTES)

4. Annex 8 Work plan

- SUBTASK 1: Remaining work requires Swedish data on ATES and BTES applications.
- SUBTASK 2: EIA for peer review among the annex 8 experts.
- SUBTASK 3: Final work to be completed
- SUBTASK 4: Final work to be completed
- SUBTASK 5: Final report on our work - annex history and progress of our work to be completed
- SUBTASK 6: Final report almost finished. Some additional work on cogeneration plants and cost-benefit analysis will be performed. The final report will be in both Turkish and English.

Annex 9. Electrical Energy Storage Technologies for Utility Network Optimization (Phase 2).

Operating Agent: J.N.Baker, EA Technology, United Kingdom

1. Introduction

The follow on, Phase 2, work programme for Annex IX was unanimously voted into force at the 43rd Executive Committee meeting, held at IEA Headquarters, Paris, France, 4th-5th December 1997. The work programme itself had previously been worked up in a process of detailed consultation with the previous (Phase 1) participants, during the latter half of calendar year 1997.

The original (Phase 1) work programme was concluded, December 1997, and the original planning called for a smooth transition to Phase 2, with immediate effect, from January 1998 on. However, in practice, many of the original participant set quite correctly wished to appraise the outputs from the first phase of the work, prior to committing to the follow on programme. This therefore led to the actual start of Phase 2 being re-scheduled until March 1998 and, even then, with it being undertaken on a part risk basis, in the absence of formal contractual commitments, from the full participant set. Once started, however, this seemed to encourage further participation and eventually contractual arrangements were concluded with the organisations as described in 2 below. At this stage further organisations would still be welcome to join.

2. Participation

Countries joining with EA Technology and the UK as participants are:-

Canada	Hydro Quebec
Germany	EUS GmbH
Netherlands	Kema T&D, Novem
Sweden	Elforsk
Finland	Helsinki University of Technology
Spain	Iberdrola
USA	Dep. of Energy (Sandia National Laboratories), ILZRO

3. Work Programme

The main activities to date have concentrated on conducting the essential preparatory groundwork, associated with the retrospective applications case studies, the forward looking project definitions, the collation/dissemination of information and the identification/initiation of complementary R&D programme activities. The first participating

agents' meeting was held at Chester in June preceding the EESAT '98 conference. The second was held on 5th October 1998, co-incident with the Energy Storage Association's Fall meeting in Atlanta Georgia, USA and the American Superconductor Power Quality Workshop on the 8 October.

There has been some difficulty in obtaining some of the information for subtask 1 and 2, which has led to a small adjustment in the timescales for completing these tasks. This has been discussed with, and agreed by the Annex participants and is not expected to affect the complete programme timescale.

A plan to improve communications between the operating agent and participants involving better use of electronic mail and telephone conferencing is to be put into operation

Annex 10. Phase Change Materials and Chemical Reactions for Thermal Energy Storage.

Operating Agent: F. Setterwall, Royal Institute of Technology, Stockholm, Sweden.

Introduction

Annex 10 was approved during the Executive Committee meeting in Paris 4-5 of December 1997. It was decided that the Department of Chemical Engineering and Technology at the Royal Institute of Technology in Stockholm, Sweden should act as Operating Agent. The Annex will be in operation for at least 3 years.

The general objective of Annex 10 is to solve technical and market problems for a better market opportunity for thermal energy storage systems utilising Phase Change Materials (PCM) or chemical reactions in the building, the agricultural and the industrial sector. The aim is to broaden the knowledgebase and disseminate information. The Annex 10 work will result in accomplished/initiated case studies and demonstration projects related to potential fields of application. This will be accomplished in close co-operation with manufacturers, utilities, users and governmental organizations involved in dissemination of energy technologies.

Participants in the annex are Bulgaria, Canada, Finland, Germany, Japan, Poland, Sweden and Turkey. Several other countries have shown interest in Annex 10, mainly China, India, United Kingdom and USA.

Activities during 1998

A First Experts Meeting and a First Workshop of the Annex was held in Adana, Turkey on the 16th and 17th of April 1998. 28 participants were from the participating countries Finland, Germany, Japan, Sweden and Turkey. 3 participants were from the Netherlands, USA and United Kingdom. A Second Experts Meeting and a Second Workshop of the Annex was held in Sofia, Bulgaria on the 11th to 13th of April 1998. 21 participants were from the participating countries Bulgaria, Canada, Finland, Germany, Japan and Sweden. 1 participant was from China. Proceedings have been published from both workshops. The second proceedings can be found by TRITA-KET R101, ISSN 1104-3466, ISRN KTH/KET/R--101—SE, both proceedings are available from the Operating Agent.

A State-of-the-art report over activities in the participating countries has been produced. The report includes information about and description of active research groups and companies that are producing or using thermal energy storage. It also gives contact information to the research groups and companies as well as their recent publications. The state-of-the-art report should be updated twice a year to every experts meeting.

An Internet site has been produced. There will be a link to a special page labeled “Companies dealing with PCM and chemical reactions for thermal energy storage”. On this page you can find links to homepages of the companies. The same will apply to universities and research institutes. All companies or other organisations that wants to be linked to the Annex 10 homepage will be allowed to join in return they will be asked to have a link to the Annex 10 homepage on their internet site. There will also be links to other Implementing

Agreements or annexes related to annex 10, e.g. Heat Pumping Technologies, Solar Energy, Buildings. The homepage can be found at http://www.ket.kth.se/Avdelningar/ts/annex10/

Work has also been done on a marketing brochure that will be published in the beginning of 1999. It will contain a description of TES by PCM and chemical reaction as well as information about the scope and work of the annex and some general information about IEA and ECES IA.

Annex 12. High Temperature Underground Thermal Energy Storage

Operating Agent; Burkhard Sanner, Giessen University, Germany

1. Introduction

The new annex on " High Temperature Underground Thermal Energy Storage (HT UTES)" Phase 1, was approved at XC43, December 1997.

Based upon the results from previous IEA activities and ongoing R&D, the objectives of Annex 12 are to demonstrate that HT-UTES can be attractive to achieve more efficient economical and environmentally benign energy systems, and to disclose requirements and find problem solutions for reliable long-term operation. The type of UTES-systems concerned shall be confined to Aquifer Storage (ATES) and Duct/Borehole Storage (DTES).

High Temperature in this annex refers to minimum storage loading temperatures on the order of 50 °C. Storage may be from short term (diurnal) to long term (seasonal), whereas "seasonal" requires the store to yield energy recovery at least three month after end of the loading period.

2. Workplan

To achieve the objectives, several activities will be carried out in two Phases:

Phase I (1.1.1998 - 30.6.1998)
State-of-the-art-review, system opportunities (from energy system side).

Phase II (1.1.1999 - 31.12.2000)
Long-term perspective and scenarios, environmental impact/benefits, development of design tools, improvement in water treatment, choice of material suited for high temperatures, and development of test equipment, HT demo projects, design guidelines.

The results shall be:

Phase I:
Evaluation and summary report of previous activities (state-of-the-art-report) and a report on R&D needs and opportunities and recommendations for Phase II

Phase II:
Ecobalance, annual reports, workshops, test equipment, design guide-lines / tools

Participating Countries are Belgium, Canada, Germany, Netherlands, Sweden, Turkey (not all yet confirmed); Operating Agent is Germany.

The work started in January 1998, a first Expert's Meeting was held in Giessen, Germany, on June 17, 1998; a workshop and the second expert's meeting is scheduled for October 14-16, 1998, in Lund, Sweden. Report to XC45 in USA, December 1998

Annex 13. Design, Construction and Maintenance of UTES Wells and Boreholes

Operating Agent: Olof Andersson, Lund Institute of Technology, Sweden

1. Objective

Most UTES (Underground Thermal Energy Storage) concepts incorporate drilling one way another. Furthermore some concepts are highly dependent on a proper well or borehole efficiency to have an optimal operational performance.

This task will cover aspects of testdrilling, well and borehole design, construction and monitoring and maintenance of UTES applications. The main target is set upon aquifer and borehole systems (in some countries refereed to as ”open” and ”closed or duct” systems).

The final goal of the task is to work out a set of guidelines covering the following subtasks.

- How to gain information of the underground properties by testdrilling (Subtask A)
- How to design well or borehole systems properly (Subtask B)
- How to construct wells or boreholes cost effective, safe and properly (Subtask C)
- How to keep the storage systems functional during operation (Subtask D)

2. Proceedings

The annex was planned during 1997 and eventually approved by the 43rd EXCO Meeting in Paris 4-5 of December 1997. Prior to the EXCO Meeting there was a Preparatory Workshop the 2nd of December to review and adjust the annex proposal.

During 1998 the following events have been executed

- Starting up Workshop in Stockton, USA the 18th of March, there the workplan and time schedule were discussed and readjusted.
- The First Expert Meeting in Giessen, Germany, June 15-16.
- The Second Expert Meeting, in Malmö, Sweden, October 12-13.

3. Results and findings

All together ten countries have been represented in the Annex during the year 1998. These are Belgium, Canada, Denmark, Germany, Japan, Netherlands, Sweden, Switzerland, Turkey and USA.

During the expert meetings, state-of-the-art information has been presented covering all subtasks.

For subtask A (site investigation methods) existing procedures to gain geoinformation have been described for most countries participating in the annex.

For borehole applications (BTES) the In Situ Thermal Response Test Method is under a marketing stage in several countries, preferably Canada, Netherlands, Sweden and USA.

For water well applications (ATES) its showed that preferably conventional methods are being used for geodocumentation. However, some countries emphasise that the usage of geophysical logging, flow logs and MWD will strengthen proper documentation.

For subtask B (well and borehole design) there are some differences in opinions when it comes to designing criteria for water wells. These differences will be further discussed in a later stage of the annex.

For borehole installations there are still research going on to optimise pipe design and back fill material. Results from these experiments have continuously been reported in the annex.

For subtask C (drilling and construction) the most common drilling and constructions methods have been described. These are more or less general for every country. However, in detail there are some differences.

Some identified questions for further discussions are

- the choice and efficiency of different well development methods
- the usage of hydraulic DTH for UTES applications
- procedures for gravel pack installations

For subtask D (maintenance) most common type of problems related to the operation of UTES systems have been identified.

Designing solutions to prevent such problems will be further analysed in a later stage.

Solutions for initial problems like well clogging, scaling and corrosion have been presented, but needs further input.

Proposed Annex

Annex 14. Cooling in All Climates with Thermal Energy Storage.

Operating Agent: Halime Paksoy, Çukurova University, Adana, Turkey.

Initially Annex 14 was first introduced as "Low Temperature UTES" at ExCo meeting in Istanbul, December 1996. Discussion on this proposed annex has continued in ExCo meetings in Sapporo (June 1997), Paris (Dec. 1997), and Chester (June 1998).
The common topics of discussions were:

- Definition of low temperature
- Countries of relevance for low temperature storage
- Overlapping or repetition of other cooling activities done by other tasks in IEA

In ExCo meeting in Albuquerque (Dec 1998), the title of the Annex was changed to "Cooling in all climates with thermal energy storage" with a new perspective. In many previous and on-going tasks in this and other Implementing Agreements, work on cooling with thermal energy storage is being accomplished. This annex may have a unifying role in bringing different options of cooling technology with TES together with the aim of determining the best of option for different climates and applications. It was decided to organise a workshop to determine this new perspective and finalise the new Annex text.

Halime Paksoy (Turkey), Frank Cruickshanks (Canada), Mari Gustafsson (Sweden), Takeshi Yoshii (Japan), Sung Hwong-Cho (Korea) are in the organizing committee for the workshop. The workshop will be held in Antalya, Turkey on June 4-5, 1999.

STRATEGIC PLAN 1999 - 2003

According to its previous decision at the December meeting 1997 in Paris the Executive Committee has been engaged in 1998 with working out a new strategy plan. There was a need to update the existing strategy plan that was already published 1991 and revised lately 1996.
V. Lottner has been assigned by the Committee to chair this special activity and to compile the new edition. Two one-day workshops have been arranged in conjunction with the regular June and December Committee Meetings in 1998. The relevant aspects and issues of the strategy plan were discussed thoroughly.
The results and findings of the discussions can be summarized:

- Audience: the strategy plan represents mainly the working document for the Committee on Energy Storage to guide its own work. It will also serve as an information basis for the IEA. For the public audience a more glossy brochure will be prepared that provides a comprehensive overwiew about the activities of the Programme as well as of the possibilities of the IEA-participation. There are also other publications available (annual reports, Task reports, Internet Website of the Storage Programme).
- Term: the extension of the existing Impl. Agreement has been approved by the EUWP for a period until 2000. Before the end of the present term the new strategy plan has to be submitted to the EUWP for another possible extension. Therefore the new strategy plan should cover also the period after 2000, that means until the year 2003.
- Topics and structure: main issues of the strategy plan are: motivation, mission and vision, market deployment, collaboration, achievements, participation, programme and future activities.

Some of the issues are highlighted in the following:
Motivation: To day the main issue are the environmental concern and a possible climatic change due to the increase of energy-related CO_2-emissions into the earth`s atmosphere. In December 1997, the Parties to the UN Framework **Convention on Climate Change** agreed to the terms of the **Kyoto Protocol**. This historical agreement sets legally-binding greenhouse gas emission objectives over the period 2008-2012 for industrialized countries. The energy sector, from supply to end uses, is responsible for the majority of greenhouse gas emissions in the developed world, through the combustion of fossil fuels and the emissions of CO_2, N_2O and CH_4.
There is a great technical potential and challenge to substitute for fossil fuels using renewable energies. Storage is a strategy component in many energy systems to improve not only the energy security but also to use more efficiently renewable energies and heat that would otherwise be wasted. Therefore storage technologies can contribute significantly to the measures requested by the Kyoto-Protocol.

Market deployment: **barriers/challenges**: After 20 years of research and development on new innovative storage concepts and technologies the wider implementation of storage systems is possible and necessary. Still existing barriers have to be addressed and overcome. The programme has to put more emphasis on this issue (e. g. information dissemination, system integration).

Collaboration: Storage systems are only ***one*** component and have to fit into a total energy system. Therefore a stronger cooperation is necessary with the other Implementing Agreements, e. g. in the building sector with the Programmes: Energy Conservation for Buildings and Community Systems, Solar Heating and Cooling, Heat Pumps, District Heating. More projects and workshops have to be carried out jointly with other Executive Committee´s in order to promote the system integration.

Achievements: So far great progress has been made within the Programme to achieve its objectives. The achievements have to be presented in the strategy paper since the future work has to be based on the results of the programme achieved so far.

Scope and Workplan: Recently the scope of the Programme has been enlarged. Now it also includes electrical energy storage technologies (Annex 9). New activities are partly follow-on work.

Participation: Some new countries have signed the Agreement. New member countries have special interest on special storage and application technologies, e. g. Japan on cold and chill storage for air conditioning of buildings. The programme has to take into account their interests adequately.

The draft of the strategy plan has been compiled in 1998. It was discussed at the second workshop in December 1998. The revised paper includes the results of both workshops. It will be reviewed once again by all Committee members and is then ready for publication in March 1999.

Other activities

1998 CERT Review - 4-year report to the EUWP

Collaborative Workshops

APPENDIX 1: LIST OF ANNEXES

Annex No.	Annex Name
	Closed Annexes
1	Large Scale Thermal Storage Systems Evaluation
2	Lake Storage Demonstration Plant in Mannheim
3	Aquifer Storage Demonstration Plant in Lausanne-Dorigny
4	Short-term Water Heat Storage Systems
5	Full-scale Latent Heat Storage Installations
6	Environmental and Chemical aspects of Thermal Energy Storage in Aquifers and Research and Development of Water Treatment Methods
7	Innovative and Cost-effective Seasonal Cold Storage Applications
	Ongoing Annexes
8	Implementing Underground Energy Storage Systems
9	Electrical Energy Storage Technologies for Utility Network Optimisation
10	Phase Change Materials and Chemical Reactions for Thermal Energy Storage
12	High Temperature UTES
13	Design, Construction and Maintenance of UTES Wells and Boreholes
	Planned Annex
14	Low Temperature UTES

Annex 1. Large Scale Thermal Storage Systems Evaluation
Annex 1 was a technical and economic evaluation of various storage concepts presented by the participating countries. The results of this work formed the basis for subsequent Annexes. The final report was published in October 1981.The Annex was formally closed at the Executive Committee Meeting in April 1983. Participating countries: Switzerland (OpA), Belgium, CEC, Denmark, Germany, Sweden, USA.

Annex 2. Lake Storage Demonstration Plant in Mannheim
Annex 2 had the objective of developing a seasonal lake storage and to demonstrate the feasibility by the construction of a large-scale pilot plant in Mannheim, Germany. Construction of the plant was cancelled after failing to achieve an economic design.

Annex 3. Aquifer Storage Demonstration Plant in Lausanne-Dorigny
Annex 3 involved the design, construction and operation of a high-temperature aquifer storage in Lausanne-Dorigny. The storage consisted of a vertical well with horizontal drains. The project was commonly called SPEOS. Waste heat from a municipal facility was stored in summer and used for space heating and domestic hot water of a gymnasium. Collaboration involved seven countries and terminated in 1989. Participating countries: Switzerland (OpA), Denmark, USA, Sweden.

Annex 4. Short-term Water Heat Storage Systems
Annex 4 reviewed the theory, techniques and application of hot water storage systems and produced a state-of-the-art report. It focused on various measures to maintain thermal stratification. The Annex was closed in 1988. Participating countries: The Netherlands (OpA), Germany, Sweden, USA

Annex 5. Full-scale Latent Heat Storage Installations

Annex 5 involved the installation and monitoring of latent energy storage installations with the objective of evaluating their technical and economic feasibility. The Executive Committee recommended reviewing the state-of-the-art of latent heat stores and a workshop was held in 1984 sponsored by the German Ministry for Research and Technology. As a result of the workshop recommendation to concentrate on monitoring pilot and demonstration plants to provide reliable performance data, an Annex on Full Scale Latent Heat Storage Installations was initiated in 1988. Germany has provided the Operating Agent. The Annex was terminated in 1992. Participating countries: Germany (Op. A), Sweden, USA.

***Annex 6. Environmental and Chemical aspects of Thermal Energy Storage in** Aquifers and Research and Development of Water Treatment Methods*

Annex 6 dealt with the chemical and environmental aspects of thermal energy storage in aquifers. A major potential problem of aquifer energy storage is the scaling an clogging of wells and heat exchangers. To avoid these problems reliable and ecologically sound methods of water treatment are required. The development and testing of the chemical, micro-biological and environmental effects of ground-water treatment methods were the objectives of Annex 6. The work was initiated in 1987 and extended through twelve experts meetings into 1993. The Netherlands provided the Operating Agent and nine countries participated. The Annex was formally closed by the Executive Committee in 1996. Participating countries: The Netherlands (Op. A), Canada, Denmark, Finland, Germany, Sweden, Switzerland, USA.

Annex 7. Innovative and Cost-effective Seasonal Cold Storage Applications

Annex 7 aimed to demonstrate innovative, energy efficient and cost-effective cold storage design for a variety of building types and industrial applications to encourage the adoption of cold storage as a standard design option. More specifically, it evaluated effective storage control and operating strategies; evaluated combined hot and cold storage for increased energy efficiency and cost- effectiveness; and conducted national market studies for the developed technologies. A planning workshop in Sweden initiated the work in January 1989 and the activities extended through eight experts meeting into 1993. The Annex was formally closed by the Executive Committee in 1996. Participating countries: Canada (Op. A), Germany, Netherlands, Sweden.

ONGOING ANNEXES, Annex 8 - Annex 13

Annex 8. Implementing Underground Thermal Energy Storage Systems

Annex 8 aims to speed the introduction of Underground Thermal Energy Storage in the building, industrial and agricultural sectors. It will encourage the adoption of energy storage in standard project designs by developing procedures and tools based upon documented applications in different energy efficient systems. Screening and decision tools will be provided to ensure ecologically sensitive applications. The first experts' meeting was held May 1994 in Sweden. Participating countries: Sweden (Op. A), Belgium, Canada, Germany, Netherlands, Turkey, USA, Japan.

Annex 9. Electrical Energy Storage Technologies for Utility Network Optimisation

Annex 9 will examine the potential role of electrical storage technologies in optimising

electricity supply and utilisation. It will identify and overcome barriers to widespread adoption of electrical energy storage technologies through successful demonstration projects. Annex 9 was proposed by EA Technology Limited of the UK as a result of the recommendations of the Energy Storage Strategy Workshop held in Montreal during January 1995. The annex started in June 1996. Participating countries: Canada, Germany, Netherlands, Sweden, UK (OpA), and USA.

Annex 10. PCM and Chemical Reactions for Thermal Energy Storage.

Annex 10 will examine the role and accelerate the introduction of phase change materials into energy systems in residential, commercial, industrial and agricultural sectors. It has been proposed by the Concordia University, Centre of Building Studies in Montreal as a result of the recommendations of the Energy Storage Strategy Workshop held in Montreal during January 1995. The Annex was approved by XC43 on December 1997. Participating countries: Bulgaria, Canada, Finland, Germany, Japan, Poland, Sweden (OpA) and Turkey. China is preparing its participation and Australia, France, India, Italy, the Netherlands, United Kingdom, and USA have shown interest in participation.

Annex 12. High Temperature UTES

Germany initially suggested Annex 12. Phase 1 of the annex was approved by XC43. This stage starts with a State-of-the-art review of HT UTES applications. It will be followed by at study in which the most promising applications and system concepts for HT-UTES are evaluated. The results will allow assessing the expected benefit of HT-UTES and justify a decision on phase II. Participating countries are not yet clear but Canada, Germany (OpA), Belgium, Sweden and the Netherlands have shown interest in the annex.

Annex 13. Design, Construction and Maintenance of UTES Wells and Boreholes.

Annex 13 is a result of the Energy Storage Strategy Workshop held in Montreal during January 1995. The annex was approved by XC43, December 1997. The objectives are to: Describe UTES drilling and exchange experiences of different technologies. Identify related problems in order to establish areas for further R&D. Work out guidelines connected to test drilling, well design and construction. Investigate the occurrences and arts of operational failures related to the well or borehole system and to work out preventive guidelines for monitoring, maintenance and rehabilitation measures. The following countries have shown interest in participation: Australia, Belgium, Canada, Germany, Italy, the Netherlands, Sweden, Switzerland, Turkey, and the U.S.

PROPOSED ANNEX

Annex 14. Cooling in All Climates with TES

This annex text has been discussed at several XC Meetings. At XC45 the name of the annex was changed to the above and it was also decided to arrange a workshop to finally decide upon the scope of the work. The workshop will be held June 1999 in Antalya, Turkey.

APPENDIX 2: PARTICIPANTS OF ECES IA (DEC. 1998)

COUNTRY	CONTRACTING PARTY
Belgium	Ministry of Economical Affairs
Canada	Public Works Canada
CEC	Commission of the European Communities
Denmark	The Ministry of Energy
Finland	TEKES, Technology Development Centre of Finland
Germany	Forschungszentrum Jülich GmbH
Italy	ENEA , Governmental Energy Research Agency
Japan	The Heat Pump and Thermal Storage Centre of Japan
Spain	IBERDROLA, Madrid (Feb 1999)
Sweden	The Swedish Council for Building Research
The Netherlands	NOVEM, The Netherlands Agency for Energy and the Environment
Turkey	Гukurova University
UK	EA Technology
USA	US Department of Energy

APPENDIX 3: LIST OF PUBLICATIONS

UTES-Publications 1998

Related to Annex 8

SANNER, B. (1998): Oberflächennahe Geothermie - Wärme- und Kälteversorgung aus dem Untergrund. - bbr 49, **4/98**, S. 34-40, Köln

SANNER, B. & RYBACH, L. (1998): Oberflächennahe Geothermie, dezentrale Nutzung geothermischer Energie. - Mitt. Deutsche Geophysik. Ges., Sonderband 1/98, S. 39-46, Hannover

SANNER, B., BOISSAVY, C., EUGSTER, W.J., VAN ECK, H. & RITTER, W. (1998): Stand der Nutzung oberflächennaher Geothermie in Mitteleuropa. - Tagungsband 5. Geothermische Fachtagung Straubing,GtV, Neubrandenburg, im Druck

SANNER, B. & NORDELL, B. (1998): Underground Thermal Energy Storage - an International Overview. - Newsletter IEA Heat Pump Center **16/2**, S. 10-14, Sittard

SANNER, B. & HELLSTRÖM, G. (1998): Examples for Underground Thermal Energy Storage with Borehole Heat Exchangers in Central and Northern Europe. - Newsletter IEA Heat Pump Center **16/2**, S. 24-26, Sittard

SANNER, B. (1998): 2. International Geothermal Heat Pump Conference im Richard Stockton College, New Jersey, März 1998. - Geothermische Energie **21/97**, S. 27-30, Neubrandenburg

SANNER, B. (1998): Vielfältige Nutzungsmöglichkeiten oberflächennaher Geothermie und die neue Richtlinie VDI 4640. - Tagungsband Hagener Bauseminar, Band 2, Hagen

SANNER, B. (1998): 5. Geothermische Fachtagung, Straubing 1998. - Wärmepumpe **8/2**, S. I-II, IZW, Karlsruhe

SANNER, B. (1998): Oberflächennahe Geothermie in Mitteleuropa im Aufwind. - Tagungsbericht Kongress renergie '98, Ökozentrum Hamm, S. 155-162, Münster

SANNER, B. (1998): Thermische Nutzung des Untergrundes - Expertengruppe der International Energy Agency tagte an der Universität. - Uni-Forum **13/4**, 1.7.98, S. 2, Gießen

LUX, R. & SANNER, B. (1998): Oberflächennahe Erdwärmenutzung. - Erdwärme, Teil IV der Reihe Regenerative Energien, S. 14-35, VDI-GET, Düsseldorf

Related to Annex 12

SANNER, B., KNOBLICH, K., KOCH, M. & ADINOLFI, M. (1998): IEA ECES Annex 12: Hochtemperatur-Erdwärmesonden- und Aquiferspeicher. - BMBF-Statusbericht '98 Solarunterstützte Nahwärmeversorgung und saisonale Wärmespeicherung, S. 141-150, Steinbeis-Transferzentrum EGS, Stuttgart

SANNER, B. & KNOBLICH, K. (1998): New IEA-activity ECES Annex 12 "High Temperature Underground Thermal Energy Storage". - Proc. 2nd International Geothermal Heat Pump Conference, Richard Stockton College, Pomona NJ, USA, im Druck

SANNER, B. & KNOBLICH, K. (1998): Thermische Untergrundspeicher hoher Temperatur, das Vorhaben ECES Annex 12 der Internationalen Energie-Agentur IEA. - Tagungsband 5. Geothermische Fachtagung Straubing,GtV, Neubrandenburg, im Druck

SANNER, B. & KNOBLICH, K. (1998): Thermische Untergrundspeicher auf höherem Temperaturniveau - Stand der Technik. - Proc. 11. Int. Sonnenforum Köln, S. 553-559, DGS, Solar Promotion Verlag, München.

Related to Annex 13

SANNER, B. & ABBAS, A.M. (1998): How can geophysical exploration help to determine GSHP Ground Properties? - Proc. 2nd International Geothermal Heat Pump Conference, Richard Stockton College, Pomona NJ, USA, im Druck

ABBAS, M.A. & SANNER, B. (1998): Wie kann Geophysik bei der Erkundung/Planung oberflächennaher Geothermie helfen? - Tagungsband 5. Geothermische Fachtagung Straubing,GtV, Neubrandenburg, im Druck

Talks + Presentations on UTES, 1998

27.1.1998, Darmstadt, TU Darmstadt
Kolloquium Geowissenchaften (zus. mit Prof. K. Knoblich)
"Oberflächennahe Geothermie - eine neue Herausforderung an die Geowissenschaften"

18.2.1998, Hagen, Südwestfälische Industrie- und Handelskammer
Hagener Bauseminar (FH Bochum / VDI Lenne-BV)
"Vielfältige Nutzungsmöglichkeiten Oberflächennaher Geothermie und die VDI-Richtlinie 4640"

28.2.1998, Böblingen Congresszentrum
Kongreß "erneuerbare energien '98"
"Heizen und Kühlen mit Erdwärmesonden und Vorstellung der saisonalen Energiespeicherung"

11.3.1998, Bonn, Haus des Deutschen Baugewerbes
Fachtagung Oberflächennahe Geothermie
"Oberflächennahe Geothermie - Dezentrale Nutzung der Erdwärme im Wohn,- Gewerbe- und Industriebau"

16.-17.3.1998, Pomona, N.J., USA, The Richard Stockton College
Geothermal Heat Pump Conference

"How can Geophysical Exploration help to determine GSHP Ground Properties?"
"New IEA-Activity ECES Annex 12: High Temperature Underground Thermal Energy Storage"

1.4.1998, Göttingen, Universität Göttingen
DGG-Kolloquium "Angewandte Geothermie"
"Oberflächennahe Geothermie, dezentrale Nutzung geothermischer Energie"

2.4.1998, Utrecht, Novem
Seminar Warmtepompen en Verticale Bodem Warmte Wisselaars
"Vertikale Erdreichwärmetauscher in internationaler Perspektive"

21.4.1998, Düsseldorf, VDI-Haus
Workshop VDI-Richtlinie 4640
"Anwendung und mögliche Anlagenkonfigurationen erdgekoppelter Wärmepumpen"

12.-14.5.1998, Straubing, Joseph-von-Fraunhofer-Halle
5. Geothermische Fachtagung
"Stand der Nutzung oberflächennaher Geothermie in Mitteleuropa"
"Thermische Untergrundspeicher hoher Temperatur, das Vorhaben ECES Annex 12 der Internationalen Energie-Agentur IEA"

19.-20.5.1998, Neckarsulm, Ballei
BMBF-Statusseminar "Solarthermie"
"IEA ECES Annex 12: Hochtemperatur-Erdwärmesonden- und Aquiferspeicher"

6.6.1998, Hamm, Öko-Zentrum NRW
renergie '98
" Oberflächennahe Geothermie in Mitteleuropa im Aufwind"

27.6.1998, Köln, Fachhochschule Köln
11. Internationale Sonnenforum der DGS
"Thermische Untergrundspeicher auf höherem Temperaturniveau - Stand der Technik"

30.6.1998, Weilburg, HILF
Weilburger Forum
"Geothermie, Wärme aus dem Inneren der Erde - regenerative Energie weltweit, in Europa, in Deutschland"

8.10.1998, Rostrup, Bau-ABC
Infotage Brunnenbau, Seminar Geothermie
"Anwendung geothermischer Verfahren in Deutschland"

16.11.1998, Warschau
IEA Seminar UTES Applications
"Geological Considerations for UTES"

"Applications of HT-UTES"

APPENDIX 4: STRATEGIC PLAN 1999 - 2003 (VOLKMARS FINAL DRAFT)

Draft (23. 12. 1998)

Strategic Plan for the IEA-Energy Storage Programme 1999 - 2003

Preface

This strategic plan of the Executive Committee outlines the scope and the goals of the IEA-Energy Storage Programme for the next 5 years (1999-2003). It will serve as the basic working document to guide the future work of the Executive Committee and will also provide a comprehensive summary for other Committees of the IEA and for the IEA-secretariat. More detailed information on the Storage Programme, especially for a public audience is published in Conference Proceedings /1/, annual reports and Task status reports of the Executive Committee, Task brochures and on the Internet-Website of the IEA-Energy Storage Programme /2/.

Introduction

Energy storage technologies are a strategic and necessary component for the efficient utilization of renewable energy sources and energy conservation. There is a great technical potential to substitute for fossil fuels using heat that would otherwise be wasted and renewable energies. These energy sources can be used more efficiently through short and long term energy storage. Thermal and electrical energy storage systems enable greater and more efficient use of these fluctuating energy sources by matching the energy supply with demand.

The Implementing Agreement on Energy Conservation Through Energy Storage was established in 1978 with the objective to facilitate the international cooperation on research, development and demonstration (R&D,D) of new, innovative energy storage technologies. Energy storage technologies are relevant in many IEA-Implementing Agreements, especially in the building, transport and traffic sectors. The cooperation with these IEA-Executive Committees is becoming more and more important in order to achieve the system integration and implementation of storage technologies.

Motivation

In 1973 after the first oil crisis, highest priority was given to improving the **energy security** of highly industrialized countries. At that time many countries were completely dependent on imported oil. Nowadays the situation has changed, the dependence on oil has been lifted, cheap fossil fuels are readily available, however the further unlimited use of fossil fuels is causing a steady increase of energy-related CO_2-emissions into the earth`s atmosphere. This

may lead to a serious problem with a possible change of world climate in the medium and long term.

In December 1997, the Parties to the UN Framework **Convention on Climate Change** agreed to the terms of the **Kyoto Protocol**. This historical agreement sets legally-binding greenhouse gas emission objectives over the period 2008-2012 for industrialized countries. The energy sector, from supply to end uses, is responsible for the majority of greenhouse gas emissions in the developed world, through the combustion of fossil fuels and the emissions of CO_2, N_2O and CH_4, three of the six gases covered by the Protocol.

Many governements have committed themselves to reduce the CO_2 emissions into the atmosphere. They have decided to strengthen their national efforts to increase the deployment of energy conservation technologies and utilization of renewable energy sources. So far in most industrialized countries, renewable energy sources contribute only marginally to the energy demand. This is due to several reasons, in particular because new energy systems are not yet economically competitive with fossil fuels, the long term reliability is not yet proven, and there are still some regulatory and market barriers which have to be overcome. Therefore, further attempts have to be made to resolve these issues. This is especially true for the variety of new energy storage technologies and concepts that have not yet been implemented on a large scale into the market.

The Executive Committee on Energy Storage has the following mission and vision for the management of the Programme:

PROGRAMME MISSION

To research, develop, implement, and integrate energy storage technologies to optimize energy utilization by improving overall energy efficiency and economic growth while benefiting the local and global environment.

PROGRAMME VISION

Energy storage technologies are able to contribute significantly to energy efficiency, the global environment, and economic growth. Therefore it is envisioned that over the next decade the IEA-Programme on Energy Storage will continually broaden the scope of their activities by undertaking research and technology development, technology transfer activities and the prototyping and deployment of near-market ready and market ready technologies. Moreover, the effective matching of energy supply with energy demand through systems integration will be emphasized, as will the expansion of collaborative actions with all interested countries and other Implementing Agreements.

Objectives and Strategies of the Programme

The Energy Storage Programme is technology, environment and market oriented. The main issues are:

TECHNOLOGY: Advance the development of energy storage technologies utilizing waste, renewable or ambient energy sources to supply space heating, space cooling and process cooling to achieve significantly improved energy efficiency and cost-effectiveness. Research and develop electrical energy storage technologies and systems that integrate batteries, flywheels, and other storage media with power electronics and control to enhance energy security and facilitate increased use of renewable energy sources. We will provide a forum to facilitate the international exchange of information and experience on energy storage research, development, project applications, field trials and products. We will ensure that adequate design information on innovative energy storage technologies is made available to interested groups in industry, government, and academia.

ENVIRONMENT: Evaluate and document the many environmental benefits of energy storage and ensure that potential environmental problems are directly addressed and avoided by sound technical analysis and design techniques. We will involve national and regional environmental agencies in our work to ensure that energy storage meets the present and future requirements of these agencies. We will raise the level of awareness and understanding of energy storage technologies, especially their environmental benefits, and ensure that impartial technical knowledge is made available to all stakeholders involved in the implementation of energy storage.

MARKET: Ensure the required steps are taken to achieve the proper application of proven energy storage technologies world-wide in the commercial, industrial and agricultural sectors. We will focus our communications efforts on the world market players including design engineers, architects, building owners, developers, governments, regulatory agencies, electric utilities, and community leaders. We will encourage the use of renewable energy sources to cool non-residential buildings in a post-CFC world; develop methods to integrate energy storage technologies into community-based systems; and develop effective residential cold storage techniques that avoid the use of conventional chillers in moderate climates. Heating and cooling applications are part of the market, but economic and technical limitations indicate that cooling is the first priority, followed by combined cooling and heating, and lastly heating. We will develop and encourage deployment of electrical storage with renewable generation technologies where market conditions favor off-grid implementation (many developing countries and remote locations world-wide). Short-term electrical storage will be investigated to improve power quality and reliability in all aspects of commercial endeavors.

In general, we will establish and strengthen new and existing internal and external international networks that may result in increased implementation world-wide of many energy storage technologies.

Market Opportunities and Barriers to Market Deployment

As with many other renewable energy and energy saving technologies, energy storage technologies offer a great market potential in the long term, but the present implementation is impeded by severe barriers.

The most important factors have been identified by the Executive Committee:

Market Opportunities

- Great energy saving and fossil fuel substitution potential.
- Opportunity to assist in meeting CO_2 emissions targets.
- Market deployment will create new jobs.
- Enhanced energy security through the use of storage technologies.

Threats and Challenges

- Energy storage technologies are not yet cost-effective in view of energy savings.
- High initial costs.
- Availability of cheap fossil fuels.
- National regulations of groundwater protection often impede the implementation of aquifer thermal energy storage.
- High technical and financial risks for the owner.
- Lack of knowledge and need for education.

Strengths and Weaknesses

The most important factors are:

Strengths

- Direct and immediate technology transfer between the participating countries.
- Strong research capacity by combining research efforts.
- International network of experts.

Weaknesses

- Lack of sufficient funds for R&D,D of thermal and electrical energy storage systems.
- Early demonstration plants had overly optimistic expectations and were not highly reliable.
- Cooperation is mainly research-oriented, there has been poor or insufficient involvement of industry.

Collaboration with other Executive Committees

Closer cooperation between the relevant Executive Committees is essential, especially for the Storage Programme. Storage technologies have to fit in the total system and have to meet the specific technical and economic requirements of the application. Integrated system concepts that include storage technologies have to be developed to achieve an optimal cost-effectiveness and energy saving potential. Therefore the Executive Committee will intensify the cooperation with other Executive Committees in the future. This will be done e. g. by joint workshops to identify new joint R&D,D activities. A close collaboration will be established in the Residential and Commercial Sector especially with the following Programmes,

- Solar Heating and Cooling;

- Energy Conservation in Buildings and Community Systems; and the
- Future Building Forum.

Achievements of the Programme

So far great progress has been made within the Programme to achieve its objectives. The main results are:

- A reliable data and information base on various energy storage technologies and concepts has been established by international reviews of the state of the art, assessment and market studies and construction and monitoring of pilot and demonstration plants.
- The technical as well the economical risks to implement new energy storage technologies have been reduced.
- National and international guidelines have been developed for the implementation of ground and aquifer storage systems to avoid the environmental risks and to facilitate installation by local water authorities.
- Design tools and computer models have been developed and are being used now by engineers for the planning and design of new energy systems that are based on energy storage technologies.
- Technology transfer and information dissemination have continued with the sponsorship of workshops and international conferences, including the series of International Thermal Energy Storage Conferences (Enerstock'85, Jigastock´88, Thermastock´91, Calorstock´94, Megastock´97) and the Electrical Energy Storage Conference (EESAT´98).
- Deployment of low temperature aquifer storage facilities for heating and cooling on a large scale in various countries, e. g., The Netherlands, Sweden, the United States of America, Switzerland, and Germany.
- Close cooperation with other Implementing Agreements (e. g., Solar Heating and Cooling, Buildings and Community Systems, Advanced Heat Pumps) has been established to avoid duplication of effort and to align the Energy Storage Programme with the interest of other IEA-Programmes. Cooperation within the Future Building Forum has been initiated.
- An Internet homepage of the IEA-Energy Storage Programme and various Tasks has been initiated.
- New member countries (Japan, Turkey, UK) have been attracted. Other countries (Poland, Spain, Bulgaria) are interested to participate in the Programme.

Scope and Workplan

The Executive Committee constitutes a forum of Senior National Programme Managers and Experts. It fulfills the following tasks:

- Task Management (Appendix 1)
- Coordination of national activities among participating countries
- Information dissemination by electonic Journals, Internet Website
- Organization of International Conferences and workshops
- Evaluation of the State-of-the-Art.

Until recently, the Storage Programme was mainly focused on thermal energy storage technologies for the heating and cooling of buildings because this sector offers the largest energy saving and substitution potential in northern countries. However, electrical energy storage systems are also very important for the stabilization and optimization of electrical energy systems as well as for the utilization of renewable energy sources, in particular in photovoltaic and wind energy systems. Therefore, the End Use Working Party recommended that the scope of the programme be broadened to include electrical and other energy storage technologies.

In January 1995 an IEA-Workshop on Energy Storage was held in Montreal to examine the opportunities and interest of cooperation in storage technologies that the IA had not previously covered in the Programme. As a result of the workshop, two new Annexes were initiated:

- Annex 9: Electrical Energy Storage Systems and Network Optimization.
- Annex 10: Phase Change Materials and Thermochemical Storage.

In 1998, the IA was extended by the Energy End-Use Working Party for 3 years until the end of the year 2000. So far 12 Tasks have been carried out, 7 of them have already been completed successfully (Appendix 1).
Special R&D activities on energy storage systems have been carried out in the context of other IEA programmes, e. g.,

- Solar PACES: (High temperature thermal storage systems for solar thermal power plants).
- Solar Heating and Cooling: Task 16 - Photovolataics in Buildings (Survey: Battery Storage Systems), Task 14 and Task 26: Advanced Solar Heating Systems (hot water storage).
- Photovoltaic Power Systems.
- Advanced Heat Pump Technologies.
- District Heating and Cooling.

Proposed Future Activities

The proposed future activities are largely extensions of the previous and present work of the Programme. Various topics and activities will be continued in order to achieve a successful implementation of storage technologies. The following list includes the activities that will be thoroughly examined by the Executive Committee.

- Follow-on to Annex 8: Implementation of underground thermal energy storage.
- Follow-on to Annex 9: Pilot and demonstration electrical storage plants. Develop consortia and explore funding mechanisms to realise demonstration scheme within a reasonable time scale.
- Evaluation of electrical storage systems for use with renewable resources and demonstration the environmental benefits of reduced CO_2 and greenhouse gas emissions.
- Research on electrical energy storage for competitive electricity supply markets and determine the economic advantages of storage for peak shaving, capital equipment deferral and frequency regulation applications.

- Annex 14: Cooling in all climates with thermal energy storage systems (Task Definition Phase).
- Comprehensive evaluation of the environmental and indoor consequences of energy storage by reviewing present national efforts and devise a validated methodology.
- Role of thermal energy storage in increasing the energy efficiency of building HVAC systems such as combined with closed-loop building heat pump systems and desiccant-based cooling systems. Cooperation with the IEA Building and Community Systems, Heat Pumping Technologies and Solar Heating and Cooling will be useful.
- Evaluation of the benefits of hot and cold storage with heat pumps, especially the advanced generation of heat pumps, in collaboration with the Heat Pump IA.
- Study the potential of water remediation efforts in conjunction with energy storage and community or aquifer-based planning of large-scale energy supply systems with the objective of assisting the implementation of energy storage in a systematic manner.
- Organisation of International Conferences, workshops and symposia:
    - TERRASTOCK-2000 (August 2000, Stuttgart, Germany)
    - EESAT 2000 (September 2000, Miami, Florida, USA)
    - Advanced solar thermal energy storage (October 1999, Freiburg, Germany) in collaboration with the Solar Heating and Cooling Programme.
- Publication of the electronic journal: Underground Thermal Storage and Utilization /2/.
- Publication of Programme and Task brochures and reports on Internet /2/.
- Continuous evaluation and preparation of state of the art reviews.
- Joint efforts should be practised to implement new energy storage technologies in all countries with an interest in storage or with a significant energy storage market potential.

Participation

The following countries have signed the IEA-Energy Storage Implementing Agreement:

Belgium, Ministry of Economical Affairs
Canada, Public Works Canada
Commission of the European Communities
Denmark, The Ministry of Energy
Finland, TEKES
Germany, Forschungszentrum Jülich GmbH
Italy, ENEA
Japan, Heat Pump and Thermal Energy Storage Centre.
Sweden, The Swedish Council for Building Research
The Netherlands, The Netherlands Agency for Energy and the Environment (NOVEM)
Turkey, Çukurova University, Adana
United Kingdom, EA Technology
United States of America, Department of Energy.

Poland, Bulgaria and Spain presently participate in various Tasks and have sent representatives to the Executive Commitee meetings. These countries are expected to become signatory countries of the Implementing Agreement on Energy Storage.

References

/1/ CALORSTOCK`94: 6th International Conference on Thermal Energy Storage, August 22-25, 1994 Espoo, Finland, Proceedings pp. 303-339.

MEGASTOCK`97: 7th International Conference on Thermal Energy Storage, June 18-21, 1997, Sapporo, Japan, Proceedings pp. 1003-1026.

EESAT 98, Electrical Energy Storage Systems Applications & Technologies, June 16-18, 1998, Chester, UK, Proceedings.

/2/ Internet Website addresses:

http://www. sb.luth.se/vatten/projects/iea/ (general information, task and annual reports)
http://www.eatl.co.uk/annexIX/home.htm and http://www. eus.de/energy-storage/ (Annex9)
http://www.geo-journal.stockton.edu (electronic journal)

Appendix 1: Current Tasks

Annex 8 Implementing Underground Thermal Energy Storage Systems.
Aims to speed the introduction of Underground Thermal Energy Storage in the building, industrial and agricultural sectors. It will encourage the adoption of energy storage in standard project designs by developing procedures and tools based upon documented applications in various energy efficient systems. Screening and decision tools will be provided to ensure ecologically sensitive applications. Sweden is providing the Operating Agent. The Annex has extended into 1999.
Duration: 1996-2000, Operating Agent: Sweden.

Annex 9: Electrical Energy Storage Systems and Network Optimization.
The overall objective of Annex 9 is to lead to the greater uptake of electric energy storage systems on utility and associated distribution networks, thereby allowing their full energy savings, operational efficiency and environmental benefits to be realised. The priority areas to be addressed in the short / medium term include the application of electrical energy storage systems in the following areas:-

- integration with renewables and non-despatchable power sources
- power quality/quality of supply
- asset management
- deferment of capacity

The scope of work includes the following elements:-

- retro-spective case studies
- forward looking project definitions
- network applications modelling
- information collation and dissemination
- formation of strategic R&D partnerships

Duration: 1996-1999. Operating Agent: UK

Annex 10: Phase Change Materials and Thermochemical Reaction Systems
The objectives of Annex 10 are in general to solve technical and market problems for a better market opportunity for thermal energy storage systems utilising PCM or chemical reactions and to broaden the knowledge base and disseminate information.

Research will be carried out to find solutions to the difficulties in using PCM or chemical reactions for thermal energy storage. In particular, research into system analysis will be carried out in order to recognise market barriers for implementing the technology in residential, commercial, industrial and agricultural sectors. The action will be executed in close co-operation with manufacturers, utilities, users, governmental representatives and organisations involved in the dissemination of energy technologies.

Annex 10 will result in accomplished and initiated case studies and demonstration projects related to potential fields of application. Furthermore, it should give general recommendations for the energy industry and more application oriented R & D activities with increased participation of industry, manufacturers, etc.
Duration: 1998-2000, Operating Agent: Sweden

Annex 12: High-Temperature Underground Thermal Energy Storage (HT-UTES)
In contrast to Annex 8 this Task deals with the storage of heat at temperatures above 50 °C. The stored heat can be used without an heat pump. HT-UTES still is not yet widely used, but might allow further applications e.g., in district heating, in waste heat recovery, in solar heating, etc. The type of UTES-systems concerned shall be confined to Aquifer Storage (ATES) and Duct / Borehole Storage (DTES).

The Task is being carried out in two Phases.

Phase I (1.1.1998 - 30.06.1999)
Based upon the results from previous IEA activities and ongoing R&D, the objectives of Annex 12 are to demonstrate that HT-UTES can achieve more efficient, economical and environmentally benign energy systems, and to disclose requirements and find solutions for reliable, long-term operation. State-of-the-art-review has been completed along with the recognition of system opportunities (from energy system side).

Phase II (1.10.1999 - 31.12.2002)
Based on the conclusions and recommendations of the Phase I review, the necessary R&D efforts will be initiated and demonstration plants erected, monitored and evaluated. Long-term perspective and scenarios will be investigated; environmental impacts and benefits will be examined; design tools and guidelines will be developed; water treatment methods implemented; and material suited for high temperatures tested.
Participating countries include Belgium, Canada, Germany, Netherlands, Sweden, and Turkey.
Duration: 1998-2001, Operating Agent: Germany.

Annex 13:
Text to be added by Olof.

Annex 14: ?

March 4, 1998

1998 CERT REVIEW OF IMPLEMENTING AGREEMENTS

IEA/OECD
ENERGY END USE WORKING PARTY (EUWP)

IMPLEMENTING AGREEMENT

on

ENERGY CONSERVATION THROUGH ENERGY STORAGE

BACKGROUND AND SUMMARY

The Implementing Agreement (IA) started the activities in 1978. At the EUWP meeting in April 1995 the IA reported activities and plans for the future. In April 1997 the EUWP and also the CERT endorsed an extension of the IA to the end of the year 2000. Finally the Governing Board decided in this way in September 1997.

After discussion with Mel Kliman, IEA, we agreed that this report should cover the period January 1995 - December 1997 and the plans for 1998. A workshop on Strategy and future plans for the Implementing Agreement was arranged in collaboration with the EUWP in Montreal by the end of January 1995. This workshop was essential for the development and its outcomes have guided the work of the IA's Executive Committee since then.

The Executive Committe of the ECES IA has produced annual reports since the start of the ECES IA. The Reports were printed since 1992. We are now working with the Strategic Plan for the period 1998 - 2000, which will be based on the present Strategic Plan, submitted 1994. The Committee has designated a working group that will comer up with a proposal to the next ExCo meeting in June 1998. The chairperson of the group is Dr. Volkmar Lottner, Germany, Member of the ExCo.

Since the latest Executive Committee meeting, in December 1997, the IA has the following annexes in operation:

- Annex 8: Implementing Underground Thermal Energy Storage. Started May 1994. Termination date May 1999. Operating Agent: Sweden

- Annex 9: Electrical Energy Storage for Utility Network Optimisation. started July 1996. Termination date June 1999. Operating Agent: United Kingdom.
- Annex 10: PCM and Chemical Reactions for Thermal Energy Storage. Started December 1997. Operating Agent: Sweden.
- Annex 12: High Temperature Thermal Energy Aquifer and Duct Storage. Phase 1 started December 1997. Operating Agent: Germany.
- Annex 13: Design, Construction and Maintenance of UTES Wells and Boreholes. Started December 1997. Operating Agent : Sweden.

The new Annexes (10-13) are to be completed by the end of 2000. An Annex on Low Temperature Energy Storage is under preparation. (Canada and Turkey).

The following countries are now (February 1998) active in the Implementing Agreement on Energy Conservation through Energy Storage: Belgium, Canada, CEC, Germany, Japan, The Netherlands, Poland, Sweden, Turkey, United Kingdom, USA. Finland has recently activated their membership. Italy has signed the IA but is passive at the moment.

Australia, Bulgaria, China, India, South Africa and Switzerland have expressed interest to participate in the activities of the IA. Australia and Bulgaria have sent observers to recent executive Committee meetings.

Guidelines and Questionnaire

A. NATURE AND OBJECTIVES

Tasks/Annexes

1. Currently active Annexes **:**
- Annex 8: Implementing Underground Thermal Energy Storage. Started May 1994; Termination May 1999
- Annex 9: Electrical Energy Storage for Utility Network Optimisation. Started July 1996; Extension Phase 2 from January 1998 and termination June 1999.
- Annex 10: PCM and Chemical Reactions for Thermal Energy Storage. Started December 1997; Termination December 2000.
- Annex 12: High Temperature Energy Storage. Started December 1997. Termination phase 1 : December 31, 1998, phase 2 December 2000.
- Annex 13: Design, Construction and Maintenance of UTES Wells and Boreholes. Started December 1997; Termination December 2000.

2. Annexes Completed in the period January 1995 - December 1997:
- Annex 6: Environmental and Chemical Aspects of Thermal Energy Storage in Aquifers and Research and Development of Water Treatment Methods. Starting 1987 and was

formally closed by The Executive Committee in January 1996. A short report is available in the Annual Report 1996.

- Annex 7: Innovative and Cost-effective Seasonal Cold Storage Applications. Started 1989 and was closed by the Executive Committee in January 1996. A short report is available in the Annual Report 1996.

3. Annexes under preparation:
- Annex 14: Low Temperature Energy Storage

Nature of Work

4 The Nature of the IA's activities

a) At the Megastock '97 there was a collaborative presentation between Germany and US on Borehole Thermal Energy Storage (BTES) applied on cold storage in Central Europe and the US. These will be followed up by a computer workshop and a presentation at the 2nd Stockton Conference i March 1998..

b) IF Technology and the Netherlands has worked in helping US (especially the State of New Jersey) in designing Aquifer Thermal Energy Storage (ATES). In particular , New Jersey has strict environmental regulations not originally designed for this use of the aquifers. Experiences from the Netherlands are tranferred to US on this issue.

c) The most important nature for the annex 12 work.

In the scope of Annex 8 there is a Collaborative Research proposal to the US NSF and Turkey TUBITAK. This would fund travelling between the two countries with two week visits to work on common interests related to BTES, ATES and environmental impacts.

d) The ExCo meetings have information exchange from each of the participating countries on the agenda at every meeting

e) On ExCo-meetings and in between through informal contacts

f) and d) Most of the formal activities are performed through annexes, workshops etc. based on task-shared and task/cost-shared basis.

All activities are important all together. The main element of the Program is the international co-operation within Annexes.

5. Main Technology area are:

Underground Thermal Energy for Heating and Cooling has been the dominant technology during the 1990's (before 1995). For annex 12: Optimisation of heat supply to buildings and processes by storing heat at elevated temperature levels for longer time.

For annex 8 from US perspective; Marketing of GHP/UTES systems. Included in this sharing Marketing research and programs of the Geothermal Heat Pump Consortium (GHPC) and setting up an Electronic Journal. also hosting a large conference.

6. Since the beginning of 1995 - the Montreal Workshop - the scope of work has extended to Electrical storage (Annex 9) and PCM and Chemical Storage (annex 10).
For annex 9 specifically we can report; phase 1 (July 1996-December 1997) :

- a comprehensive state of the art review of electrical energy storage technologies world-wide (Flywheel energy storage, power electronics, batteries, Superconducting Magnetic Energy Storage, fuel cells, etc,), including comprehensive information from the various participating countries.
- a comprehensive and updated directory of storage systems developers, manufacturers and suppliers
- a critical examination of utility requirements for electrical energy storage systems
- a techno-economic cost/benefit model, to enable authoritative assessments of different storage/applications matches to be assessed
- an energy/emissions model, to enable the energy/emissions benefits of different storage systems/applications matches to be assessed

Phase 2 (January 1998-June 1999):

- the execution and delivery of a series of authoritative applications case studies, suitable for widespread dissemination
- the delivery of two fully costed project definitions, to be used as the basis for any follow on applications, demonstration schemes
- the development and delivery of a storage systems network applications model
- the ongoing collation and dissemination of applications and systems information and data
- the production of a selected series of educational and promotional material
- the establishment of a planning framework for future EESAT conferences
- the spawning of a series of complementary R&D programme activities, to feed into the parent Annex 9, phase 2 work programme
- complemented by the inauguration of the EESAT conference series (EESAT - Electrical Energy Storage Systems, Application & Technologies)

7. Further applications of the studied technologies. Example: Low Temperature Storage. Further project proposals are endorsed continuously by the ExCo. The added tasks are the establishment of an electronic Journal. The establishment of funding for transfer of UTES technology to economically emerging nations or those with large infrastructure changes such as Turkey and Poland.

Objectives

8. According to the present Strategy Plan (December 1996) the Objectives are:

" The overall objective of the Implementing Agreement on Energy Conservation through Energy Storage is to develop and demonstrate various advanced energy storage technologies for applications within a variety of energy systems and to encourage their use as a standard design option. Energy storage technologies can improve the utilization of renewable energies, in particular solar and wind and the greater utilization of waste heat. Energy storage technologies should be implemented in all countries with a significant energy storage market potential".

9. No, We do not think so. The work is consistent with the objectives set forth in the agreement.

10. Yes, in principle. We might add something about Research, Development and Demonstration in the next version of the Strategic Plan..

11. We were, before the Montreal-Workshop in January 1995, asked by the EUWP to broaden the scope of work. See also question 6.
For Annex 9 the main technology areas/issues being addressed are:

- application of electrical energy storage systems
- integration of renewables and non-despatchable power sources
- modelling
- cost/benefit ratios
- system technologies, including: battery storage, flywheels, capacitors, SMES, compressed air/hydro and fuel cell/electrolyse systems.

B. PARTICIPATION

1. Countries and organisations (Contracting Parties) participating in the Implementing Agreement on Energy Conservation through Energy Storage:

Belgium	Ministry of Economic Affairs. Governmental. Annex 8.
Bulgaria	.... Interest in annex 10 (recent member).
Canada	Public Works. Governmental Agency. Annex 8, 9, 10, 12, 13
CEC	DG XII. No participation at the moment, but will reactivate its participation

Denmark	Ministry of Energy . No annex participation at the moment. Expressed recent interest in annex 8.
Finland	TEKES. Governmental Agency. No annex participation at the moment. Interest in Annex 9, 10
Germany	Forschungzentrum Jülich, GmbH. Governmental Agency. Annex 8, 9, 10, 12, 13
Italy	ENEA, Governmental Energy Research Agency. Passive member. No annex participation
Japan	Heat Pump and Thermal Energy Storage Center of Japan. Industrial and Governmental Agency. Annex 8, 10.....
Sweden	The Swedish Council for Building Research. Governmental Agency. Annex 8, 9, 10, 12, 13.
The Netherlands	NOVEM, The Netherlands Agency for Energy and the Environment. Governmental Agency. Annex 8, 9, 10, 12, 13
Turkey	Çukurova University, Adana. ”Academic”. Annex 8, 10, (12, 13).
UK	EA Technology. Consultancy Company. Annex 9...
USA	US Department of Energy. Annex 8, 9.....

Witin the Annexes research institutes, engineering and industrial companies (e.g. electric utilities, manufacturers) work together to develop and demonstrate new energy storage technologies.

Member Countries

2. France, Austria, Korea, Australia and countries listed above, in Background and Summary. We work with promotion activities but have not reached the ultimate goal yet! Switzerland, for example, is not participating in ECES IA yet, in spite of their long experience and many activities.

3. Yes. The best thing to ”sell” the IA according to our opinion is to work with attractive annexes and information activities. Storage is important in today’s and tomorrow’s energy system.

Non-Member Countries

4. Poland and Bulgaria.

5. Yes. Every country contributes with new experiences, especially the less developed countries have differing requirements and economics

6. Yes. Endorsement of promotion and open attitude from the IA's to NMC's. Contacts with NMC-countries are very helpful to "sharpen the eye" for special needs.

Other Participants

7.
a) ExCo, mainly official delegates: See also question B1. Industry is involved especially in the Tasks/Annexes. Annex 9, but also in the other annexes. Different "rules" in different countries.

b) Yes. Example: There will be a large involvement of Utilities, Manufacturers and Design Professionals at the upcoming conference at Stockton in March 1998 and over 180 from this segment participated at the first meeting.

c) More or less a rule in Annex 9 ; The Industry is directly involved in the various activities. National Team participants have been actively involved in the various activities of the Annex, including the successful programme of Expert's meetings and in response to the various technical questionnaires etc.

d) GHPC has supplied reports on Design Tools, Marketing and Education for Designers.

8. Yes. see question B1 and 7.

9. Increasing in the annex work and also as attendees at workshops. Industrial involvement is sometimes difficult, in particular where rapid return of money is not expected. It varies according to technology and the market position of a certain technique in the countries. So in annex 12, for example- according to the OA - it is expected to be easier in the Netherlands and Sweden, and consulting companies from these countries are involved since some years. The monetary contribution from the companies, is however, not always a reciept of their involvement in the project work. In Canada, in particular, R&D on a more academic level has to be strengthened to offer promising prospects to the industry and thus to attract their participation.

10. We believe so indeed. For instance, industry can be involved to a larger extent in demonstration projects.

C. ACTIVITIES

Meetings

1. a) The Executive Committee meetings are normally twice a year. Average attendence during last three meetings has been 25 people.

b). Technical Meetings and Workshops, Annex experts meetings 2-4 times a year, about the same with workshops. Annex meetings attendence about 12 ans associated Workshops 40 people. Annex 8 experts had many participants and presentations at the MEGASTOCK '97 conference and are dominating at the Stockton Conference in March 1998, c.f question B 7 b). b).

For annex 12, two experts meeting during 1998 are scheduled, with some 8 participants, and one workshop for up to 30 people. In addition national workshops will be organised to collect the information for the International State of the art review.

c) Seminars and conferences . One International Conference every three years. The latest MEGASTOCK '97 one in Sapporo 1997. Usually 100 papers and 200 attendees. Seminars 1 - 2 times a year. (C.f 1 b).

Costs of Agreement

2. It differs a lot from country to country. Up to now, the "Chairperson- and secretary-country" has taken the costs for the secretariat - chairperson and secretary - and the responsibility for that has circulated around the countries. Most of the annexes are run on task-sharing or combined cost/task-sharing basis. Also difficult to calculate are the reports from the GHPC as well as the sum of the costs of travelling. Example from the Stockton Conferences: Total cost more than $ 200,000 to put on together. the monitoring results of the RSC UTES project - the total research funds for monitoring is in excess of $ 1.2 million. Above that there are a number of smaller projects connected to various activities.

a) We do not have any common fund for the IA . The work of the Operating Agent in Annex 9 is jointly funded. (Phase 1: £ 150,000; Phase 2: £150,000)

b) Difficult to calculate. The International collaboration is, in many cases, integrated with national activities. Annex 12 (1998): One person month is required from each participating country for the international co-operation within the Annex.

c) Example: EESAT '98 is planned as the major open access dissemination event for the Annex 9 and is to be self supporting financially, open to both participants and non-participants. For annex 12; relevant work linked to the annex in Germany approx. USD 100.000 .

Information exchange. More Examples: Additional value of the benefits of the information exchange is the collaborative projects and student and other personell exchange program. Examples from Turkey:

- Collaborative project for feasibility study of ATES to a Hospital was realised by task-sharing and financial support from National project resources.
- Student exchange is financed by international Scholarship programs: PhD student visiting the Technical University of Luleå, Sweden to study cold storage and one geological engineering student visiting VBB/VIAK, Malmö, Sweden, for training in pump tests in ATES and modelling at the Technical University of Lund, Sweden.

Dissemination of Results

3. A list of publications is attached to each annual report during the period. Please, look at these lists. Moreover, the annex 8 and annex 9 are working with these matters. Example: Proceedings from the Stockton conference will form the first issue of the Electronic Journal.. the web site has just been set up. A special Task of the Executive Committee Member is the national dissemination of the IEA activities and results.

Examples: The IA: Conference proceedings, Internet, Publications. Annexes: Workshop Proceedings, State of the Art reports

4. The ExCo and annex 8 and 9 have home pages. The annex 9 will also arrange an International Conference in June 1998 (see above) to introduce a forum for information for and discussion of the results and activities. Discussions underway for an electronic storage newsletter and possibly a list server discussion group.

5. During the period of this report 5 new countries have joined the IA and the annexes 8 - 13 have started The development will continue during the period of the IA's extension, (1998-2000). The Draft Strategic plan will be discussed at the first time at the next ExCo meeting in June, 1998.

Co-ordination with Other Bodies

6. Energy storage is a technology which is important in an energy system. A storage plant does not, however, work only by itself. It is one component of an energy system. In systems with solar, heat pumps and district heating and cooling for example storage systems are essential for the utilization of renewables or waste heat. The system efficiency will increase. It is therefore natural to collaborate with the IAs representing these technologies, including the Energy Conservation in Buildings and Community Systems (ECBS) IA. as well as with the Demand Side Management (DSM)We have also collaboration with the EETIC IA for co-ordinating information activities, etc.

Some of the members of the ExCo are also members of other ExCos and consequently, information exchange and strategic collaboration can easily be discussed with other relevant IAs. Examples: The Swedish delegate is also a member of the Heat Pumping ExCo and the German delegate of the Solar Heating and Cooling ExCo.

7. No formal arrangements at the moment. More person to person. Members of the ExCo are often delegates in more than one Committee and / or have colleagues working in other Committees.See question 6, above.

8. Coordination could start with the European Union with the new delegate in the Committee.
We are interested in the report from the collaborative IEA-EU meeting last June in Brussels and the actions from the organisations that came out from that meeting.

Internal Assessment and Planning

9. We use the Executive Committee and their National network of experts for built - in review.

10.We have a Strategic plan for the period 1994 - 1997. (sent by mail separately) At the latest ExCo- meeting (December 1997) we decided to review and update it and make it valid for the period 1998-2000. A draft will be discussed at the next ExCo meeting in June, 1998.

11.We have designated a group to work with the new Strategic Plan for the period 1998-2000 according to the procedure in question 10. The last time was 1993 - 1994 ending up the 1994 Strategy Plan set for the period 1994-1997. As the plan was formally expired by the end of December last year, we decided that we should review and renew it.

12. We have pursued the objectives of our plan and have successfully achieved most of them. We also work with the current reality and situation. The reality leads the way we run the IA and the Strategic plan is our way to predict it. From the Workshop in Montreal January 1995 and the meeting with the EEUWP in April 1995 gave the ExCo clear instructions.

D. ACHIEVEMENTS AND BENEFITS OF CO-OPERATION

Technology Development

1. Previous annexes have substantially contributed to ***technology development*** and have been crucial for the continuous development. Annex 8 and 9 are also important for the development. The Annex 9 is not a R&D Annex, rather an applications annex. The other new annexes 10-13 started Decemeber 1997 so they have not contributed yet.

2. The Annex 6 work with the continuation of aquifer storage technologies. The Chemical and micro-biological problems were about to jeopardise the technology in the 1980's. Annex 7 with the international development of Cold Storage technologies. Annex 8 with the further implementation of aquifer and borehole storage technology. Annex 9 with the successful introduction of the important technology of storing electricity.

3. See publication lists in the annual reports. Example. The Stockton project (A large borehole storage plant) and its videotapes have influenced many large projects including some in the US (California, Virginia, etc.) as well as in Sweden and Germany. Examples: There is an article in Swedish Building Research 1997, From Conference information US found out about a Swiss roadway deicing project and Energy Piles. There are now one of each of those projects in the US. (Even though the data was never asked for , the ideas and success was transmitted to the US.) Within the annex 7 - 4 important German publications 1994-1997. Annex 8: workshops in Adana, Turkey (1995), Halifax, Canada, (1996), Leuwen, Belgium, (1997), Stockton, USA (March 1998).

2., 5. (additional information) Cold storage is a real success technical and economical, not only in Sweden and the Netherlands. Several plants with direct cooling have been built in Germany after the end of annex 7, started through publications related to that annex. In particular, in combination with the newly developed "Energy Piles", underground cold storage, is rather successful and now growth without further help from governmental financing. Some examples:
- GSHP with direct cooling for the Neantertal Museum, Mettman, Germany (1996)
- Aquifer cold storage for the Reichtag Building, Berlin, Germany (under construction. ready 1999).
- Energy Piles with cold storage for the Main Tower of the Helaba - bank. Frankfurt, Germany. (under construction, ready 1999).
- a number of smaller plants with GSHP and direct cooling for office buildings at various places in Germany.

Technology Deployment

4.Through the annex works; in particular annexes 6, 7, 8, 9. This occurs through demonstrations in each country. For example, in the Netherlands the Annexes 6 and 7 have led directly to a large-scale implementation program.

5. Annex 8: Implementation of an extensive program on demonstration plants in the Netherlands.
Annex 9: The production of the software assessment packages and the increased understanding of the systems applicability has already focused thoughts on a number of possible applications demonstration schemes, to be addressed in the second phase of the annex 9.

6. Various publications about Low Temperature Thermal Energy Storage in Ducts and Aquifers by CADDET (Sanner, Hellström, Nordell)
Assisting the Geothermal Consortium in the USA with modelling, etc.

Networking

7. Example: We will contribute to the Heat Pumping Newsletter with information about the activities of the IA.

8. Each of the active persons contributes to the dissemination of information in the country. There are national networks, often in form of National Teams.

9. The strengths are the network with people that know each other well and have short ways of communication and they represent different positions in the society. Example: The Lund University SBM model was an important tool in designing the Stockton UTES system and Göran Hellström, project manager, was instrumental in giving access to software

Policy Relevance

10. Internationally, yes. Hopefully, yes, in most of the countries. Example from the US. The New Jersey Board of Public Utilities and the US DoE are funding a project to re-write environmental regulations to reduce first cost barriers while ensuring the integrity of the ground water for drinking. Work from the Netherlands and other participating countries will help in this analysis

11. To some extent, yes. Non-member countries have expressed interest to participate in annexes and the IA.

Environment

12. The Environment issues are important and go through all the activities. Annex 7: System analysis of cold storage UTES including environmental impact, in particular reductions of carbon-dioxide-emissions. See also #10.

More efficient Use of Resources

13. This is the way we work in the annexes. task or task/cost sharing activities in all annexes. Technical workshops are arranged to discuss results and technical matters.
Examples:
Annex 7: Shared system analysis, each participating country responsible for 2 alternatives - out of 8 - results of value, results of value to everybody
Annex 8: Shared activities in dissemination (e.g. Workshops), software list etc. Shared efforts in state of the art reports.

14. For all activities : Avoid earlier mistakes. State of the art reports are essential.
Example from the start-up process of annex 12:
A first discussion on continuing co-operative R&D within the IEA framework took place at a HT-UTES workshop in June, 1996, during the IEA ECES Annex 8 expert's meeting in Halifax, Canada. In April 1997, a dedicated workshop on HT-UTES within IEA ECES was performed in Berlin, Germany with international attendance. This workshop was a platform for a first review of the state of the art and the future opportunities, and resulted in the recommendation to proceed in establishing a relevant annex. In December 1997 just before the ExCo-meeting, a final preparatory meeting took place in Paris, France, and the annex was accepted by the ExCo at the December 1997 meeting. The preparatory activities helped to shape the objectives and workplan and allowed to begin with information exchange at an early stage.

The objectives of this annex are to demonstrate that the HT-UTES can be attractive to achieve more efficient economical and environmentally benign energy systems, and to disclose requirements and find problem solutions for reliable long-term operation. The type of UTES-systems concerned shall be confined to Aquifer storage (ATES) and Borehole/Duct storage (DTES).

Various benefits will be achieved with HT-UTES (Annex 12):

- Energy conservation (as stated in the tile of the IA). HT-UTES will allow to use renewable energies like solar thermal energy, which otherwise has bad characteristics in matching time of heat load and supply, and to make use of waste heat in times where no heat load exists. In consequence, other (fossil) primary energy can be saved. Using HT-UTES, also the energy necessary for recovering the heat can be minimised.

- Environmental benefits (reduction of emissions). In unison with energy conservation the emission of carbon dioxide and noxious gases will be reduced substantially. If waste heat can be used for storage, then also thermal pollution caused be dumping this heat into the environment can be mitigated. HT-UTES might here play a double role with reducing flue gas emissions and decreasing thermal emissions simultaneously.
- Economic benefits and improved reliability. It is expected to achieve eventually a good economic basis for HT-UTES, at least in plants making use of otherwise wasted thermal energy. Reliability can be very high, provided the relevant techniques (e.g. water treatment) will successfully be demonstrated.

15. For most of the countries - yes. Examples to be found at various places in this document.

Overall Significance of Agreement

16. Initiation of several new Annexes with new topics (e.g. electrical energy storage in Annex 9). Reaching out to new communities of storage technologies such as fuel cells, batteries, flywheels, SMES, renewables and making their work relevant to electrical utility planning.

17. We do not know about the rating, but the IAs with over 20 participating countries and a strong history are of course stronger. IAs dealing with energy production in any form creates easier understanding from people outside the ”inner circle”. To utilize the strength and the body of the IEA is a very easy and efficient co-operation on the expert’s level

18. Broadening the scope of work, starting new annexes will certainly attract new countries. The ongoing annexes are the motor of the IA.